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VOLUME II of II

OPERATORS' MANUAL

for

OSCILLOSCOPE AN/USM-281

DEPARTMENT OF THE NAVY

BUREAU OF SHIPS

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SECTION 3

OPERATION

3-1. GENERAL.

This section contains information necessary for the operation of the AN/USM-281 Oscilloscope and includes an operational description, a description of the operating controls and connectors and operating procedures for the instrument. The operator should be thoroughly familiar with this section before attempting to operate the instrument.

3-2. FUNCTIONAL OPERATION.

The AN/USM-281 Oscilloscope is a direct coupled, wideband oscilloscope that provides a visual display of simple and complex waveforms. In addition to observing waveforms, the oscilloscope provides the user with the capability of accurately measuring rise time of any portion of a waveform, waveform magnitude, time difference between any two points on a displayed waveform and accurate time comparison of two separate waveforms.

a. OSCILLOSCOPE ASSEMBLY OPERATIONAL DESCRIPTION. - The oscilloscope assembly provides the circuitry (low voltage and high voltage power supplies) for projecting a beam onto the CRT screen and the controls to adjust intensity, focus (sharpness) and horizontal position of the beam on the CRT. This unit also contains a horizontal amplifier (with front-panel controls for accepting an internal or external signal) to amplify the selected time base signal and provide a linear deflection voltage to the horizontal plates of the CRT. The oscilloscope assembly also contains the power switch, scale illumination control and two calibrator output jacks.

b. TIME BASE AND DELAY GENERATOR OPERATIONAL DESCRIPTION. - The time base and delay generator plug-in assembly receives operating power from the oscilloscope low voltage supply through a connector on the rear of the plug-in unit. This assembly generates the accurate main time base and delay time base voltages used for horizontal deflection during normal (internal) operation. Front-panel controls provide a choice of four modes of operation: main sweep only, mixed sweep, delayed sweep and single sweep. With the sweep mode selected, a concentric front-panel control provides a choice of 23 sweep speeds for the main sweep, and 18 sweep speeds for the delayed sweep. The time base assembly also provides controls for selecting automatic (free-running or triggered by a signal above 50 Hz) or triggered time base, trigger source, polarity, level, frequency range and a calibrated ten-turn control for precise measurement of the delay time to the start of the delayed sweep.

c. DUAL CHANNEL VERTICAL AMPLIFIER OPERATIONAL DESCRIPTION.- The dual channel vertical amplifier plug-in assembly receives operating power from the oscilloscope low voltage power supply through a connector on the time base and delay generator plug-in assembly. The dual channel vertical amplifier contains two separate frequency-compensated dc amplifiers capable of displaying waveforms from dc to 50 MHz with 3% accuracy. Front-panel controls provide three types of operation: a single trace using either channel, a single trace algebraically combining the inputs of the two separate channels and three modes of dual-trace operation. The dual-trace modes available are: a dual trace displayed on alternate sweeps and triggered by the composite input signal, a dual trace displayed on alternate sweeps and triggered by the B channel input signal only and a dual trace displayed on a chopped sweep that switches at a 400 kHz rate and is triggered by the B channel input signal. Front-panel polarity switches provide for inverting the waveform on either channel when displayed separately or alternately and allow the operator to choose the algebraic combination (A+B, -A+B, -A-B, +A-B) of the two waveforms displayed on a single trace. Controls are also provided for vertically positioning each trace; dc balance of each channel separately, and dc balance of the combined channels; calibrated input attenuation of each channel; X5 magnification and input coupling selection (ac or dc).

3-3. DESCRIPTION OF CONTROLS AND CONNECTORS.

a. FRONT-PANEL CONTROLS AND CONNECTORS.- Figure 3-1 identifies all front-panel controls and connectors. Table 3-1 lists the description and function of these controls.

b. REAR-PANEL CONTROLS AND CONNECTORS.- Figure 3-2 identifies rear-panel controls and connectors. Table 3-2 lists the description and function of these controls.

TABLE 3-1. FRONT-PANEL OPERATING CONTROLS AND CONNECTORS

FIG NO./ INDEX NO.	CONTROL OR CONNECTOR	DESCRIPTION	FUNCTION
3-1, 1	HORIZONTAL POSITION (fine) control	Variable resistor A1R218	Used for fine adjustment of display's horizontal position.

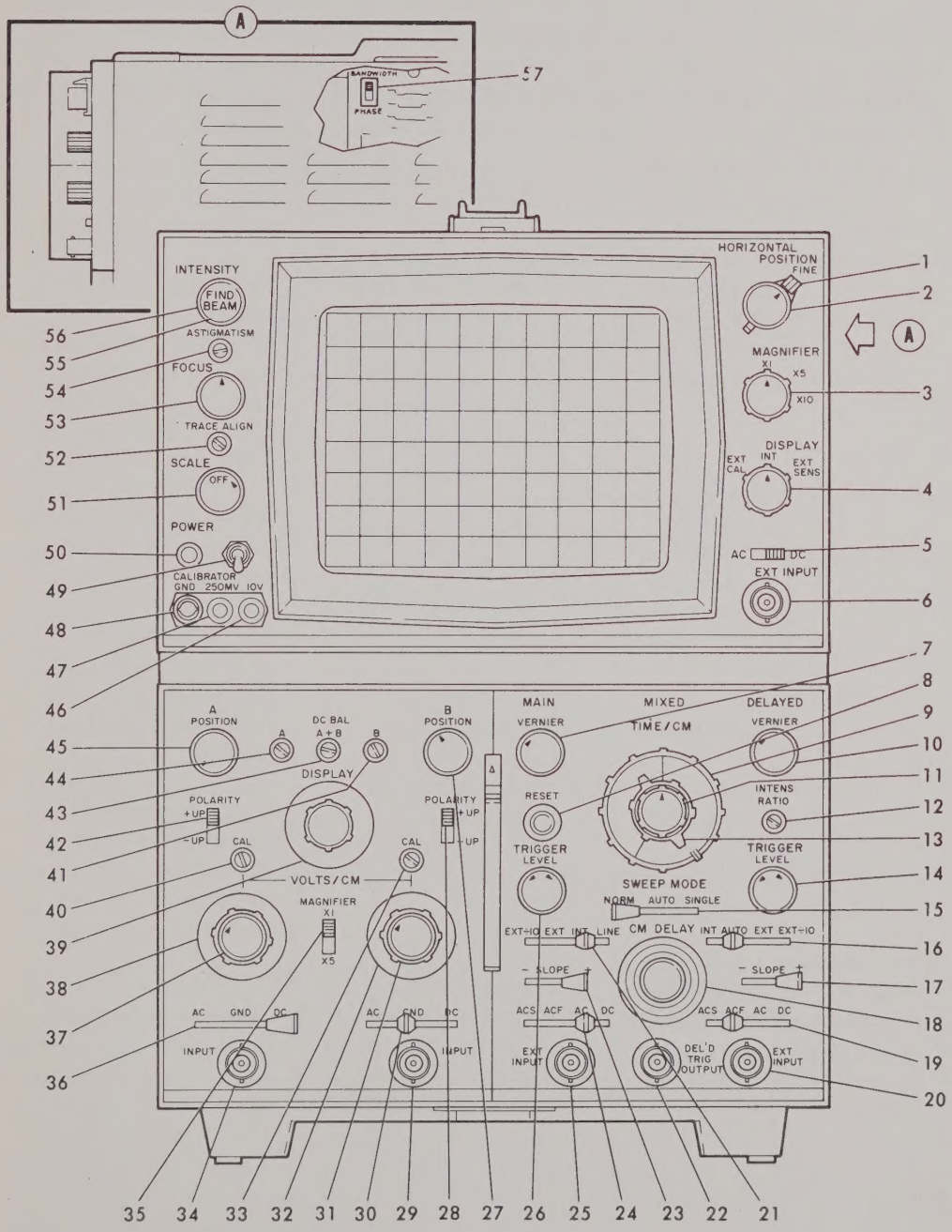

Figure 3-1. Front-Panel Controls and Connectors

TABLE 3-1. (Continued)

FIG NO./ INDEX NO.	CONTROL OR CONNECTOR	DESCRIPTION	FUNCTION
3-1, 2	HORIZONTAL POSITION (coarse) control	Variable resistor A1R221	Used for coarse adjustment of display's horizontal position.
3-1, 3	Horizontal MAGNIFIER switch	Three-position rotary switch A1S203	This switch determines gain of the horizontal amplifier and is used to magnify or expand the trace. Position functions are as follows: X1: Provides normal 10 cm sweep (for 10 v input). X5: Expands trace to 5 times normal (provides 50 cm of deflection for 10 v input). X10: Expands trace to 10 times normal (provides 100 cm of deflection for 10 v input).
3-1, 4	Horizontal DISPLAY switch	Ganged three-position rotary switch A1S101 and variable resistor A1R211	This switch determines which time base signal is applied to the horizontal amplifier. Position functions are as follows:

TABLE 3-1. (Continued)

FIG NO./ INDEX NO.	CONTROL OR CONNECTOR	DESCRIPTION	FUNCTION
			INT: Connects horizontal amplifier input to internal time base and delay generator. EXT CAL: Connects horizontal amplifier input to EXT INPUT connector. EXT SENS: Connects horizontal amplifier input to EXT INPUT connector through variable resistor. When control is rotated ccw from EXT CAL to INT, input signal is increasingly attenuated.
3-1, 5	Horizontal amplifier external input coupling switch (AC DC)	Two-position slide switch A1S201	This switch selects type of coupling for an external signal. Position functions are as follows: AC: Connects EXT INPUT connector (6) to DISPLAY switch (4) through capacitor to block dc component of external signal.

TABLE 3-1. (Continued)

FIG NO./ INDEX NO.	CONTROL OR CONNECTOR	DESCRIPTION	FUNCTION
			DC: Connects EXT INPUT connector directly to DISPLAY switch.
3-1, 6	Horizontal amplifier EXT INPUT connector	BNC connector A1J201	Connector for coupling an external signal to horizontal amplifier.
3-1, 7	MAIN VERNIER control	Variable resistor A3R235 with switch	This control is the vernier adjustment of the main sweep speed. Position functions are as follows: CAL: Allows main sweep time to be read directly from main TIME/CM switch (13). Rotated ccw from CAL: Provides continuous adjustment of sweep time between the calibrated steps of the main TIME/CM switch (13).
3-1, 8	RESET pushbutton - indicator	Pushbutton and indicator lamp A3S201 and A3DS201	When SWEEP MODE (15) is set to SINGLE trace, pressing RESET pushbutton arms sweep circuit and allows trace to

TABLE 3-1. (Continued)

FIG NO./ INDEX NO.	CONTROL OR CONNECTOR	DESCRIPTION	FUNCTION
3-1, 8 (Cont)			start on next trigger signal. The sweep circuit must be reset between each trace. Neon indicator lights when sweep is reset and trace armed.
3-1, 9	Delayed TIME/ CM switch	19-position rotary switch A3S503	Selects delayed sweep speed. Interlocked with main TIME/CM switch (13) so that delayed sweep is always faster than main sweep.
3-1, 10	DELAYED VERNIER control	Variable resistor A3R420 with switch	This control is the vernier adjustment of the delayed sweep speed. Position functions are as follows: CAL: Allows delayed sweep time to be read directly from delayed TIME/CM switch (9). Rotated ccw from CAL: Provides continuous adjustment of sweep time between the calibrated steps of the delayed TIME/CM switch (9).

TABLE 3-1. (Continued)

FIG NO./ INDEX NO.	CONTROL OR CONNECTOR	DESCRIPTION	FUNCTION
3-1, 11	Sweep display switch	Three-position rotary switch A3S502	Determines the type of sweep to be displayed. Position functions are as follows: MAIN: Displays main sweep only. If delayed TIME/CM switch (9) is rotated ccw from OFF, a portion of the main sweep is intensified. MIXED: In this position the first portion of the trace is produced by the main sweep and the last part of the sweep is produced by the delayed sweep. The CM DELAY control (18) determines at what point the delayed sweep starts. DELAYED: Delayed sweep only is displayed at a time delay determined by the setting of the CM DELAY (18) and main TIME/CM switch (13). Delay time is the product of these two switches.

TABLE 3-1. (Continued)

FIG NO./ INDEX NO.	CONTROL OR CONNECTOR	DESCRIPTION	FUNCTION
3-1, 12	INTENS RATIO control	Variable resistor A3R525	Determines intensity difference (contrast) between main and delayed sweep.
3-1, 13	Main TIME/ CM switch	23-position rotary switch A3S501	Selects main sweep speed. Interlocked with delayed TIME/ CM switch (9) so that main sweep is always slower than delayed sweep.
3-1, 14	Delayed TRIGGER LEVEL control	Variable resistor A3R313	Determines voltage level on waveform at which delayed sweep is triggered. Variable from -5 volts to +5 volts. This switch does not function when the delayed trigger source switch (16) is set to AUTO.
3-1, 15	SWEEP MODE switch	Three-position lever switch A3S104	This switch determines the type of main sweep operation. Position functions are as follows: NORM: Provides a sweep only when a trigger signal is present. Used when trigger frequency is less than 50 Hz or

TABLE 3-1. (Continued)

FIG NO./ INDEX NO.	CONTROL OR CONNECTOR	DESCRIPTION	FUNCTION
3-1, 15 (Cont)			when triggering signal is erratic. AUTO: Provides a free-running sweep when no trigger signal is present and a triggered sweep if a trigger signal with a frequency of 50 Hz or greater is present. This is the normal operating position for this control. SINGLE: Provides only one sweep when triggered. Must be manually reset before each sweep.
3-1, 16	Delayed trigger source switch (INT AUTO EXT EXT÷ 10)	Four-position lever switch A3S301	This switch selects the triggering source for the delayed time base generator. Position functions are as follows: INT: Connects delayed time base triggering circuitry to an internal trigger signal derived from the vertical input signal. In this position the delayed sweep starts on the first

TABLE 3-1. (Continued)

FIG NO./ INDEX NO.	CONTROL OR CONNECTOR	DESCRIPTION	FUNCTION
3-1, 16 (Cont)			trigger pulse received after the delay time. AUTO: In this position the delayed sweep starts immediately at the expiration of the delay time. The delayed TRIGGER LEVEL, (14) delayed SLOPE (17), and the delayed trigger coupling (19) do not function when this switch is in the AUTO position. This is the normal operating position for this switch. EXT: Connects delayed time base triggering circuitry directly to delayed EXT INPUT connector (20). This position is used to trigger delayed time base from an external trigger signal of less than 10 v peak-to-peak. Delayed sweep starts on the first trigger pulse received after delay time.

TABLE 3-1. (Continued)

FIG NO./ INDEX NO.	CONTROL OR CONNECTOR	DESCRIPTION	FUNCTION
3-1, 16 (Cont)			EXT ÷10: Connects delayed time base triggering circuitry to delayed EXT INPUT connector (20) through an X10 attenuator. This position is used if the external trigger signal is greater than 10 v peak-to-peak.
3-1, 17	Delayed SLOPE switch	Two-position lever switch A3S303	This switch determines on which slope of the triggering signal the delayed time base starts. This switch does not function when the delayed trigger source switch (16) is set to AUTO. Position functions are as follows: - : In this position the delayed sweep starts on the negative-going (downward) portion of the triggering signal at a trigger level determined by the setting of the delayed TRIGGER LEVEL control (14).

TABLE 3-1. (Continued)

FIG NO./ INDEX NO.	CONTROL OR CONNECTOR	DESCRIPTION	FUNCTION
3-1, 17 (Cont)			+: In this position the delayed sweep starts on the positive-going (upward) portion of the triggering signal at a trigger level determined by the setting of the delayed TRIGGER LEVEL control (14).
3-1, 18	CM DELAY control	Ten-turn variable resistor A3R471	This control in combination with the main TIME/CM switch (13) determines the delay time before the start of the delayed time base. The delay time is the product of the setting of these two controls. For example: A CM DELAY setting of 4.00 and a main TIME/CM setting of 1 MSEC/CM would produce a delay time of 4.00 x 1 msec or 4 msec.
3-1, 19	Delayed trigger coupling switch	Four-position lever switch A3S302	This switch determines the type of trigger coupling for the delayed time base generator. This switch does not function when the delayed

TABLE 3-1. (Continued)

FIG NO./ INDEX NO.	CONTROL OR CONNECTOR	DESCRIPTION	FUNCTION
3-1, 19 (Cont)			trigger source switch (16) is set to AUTO. Position functions are as follows: ACS: The ac slow position attenuates signals above approximately 30 kHz. This position is used to remove an undesirable high frequency component from the trigger signal. ACF: The ac fast position attenuates signals below 15 kHz. This position is used to remove the low frequency component (such as 60 Hz ripple) from the trigger signal. AC: The AC position blocks the dc level of the trigger signal. This position is used on frequencies above 20 Hz when it is desirable to remove the dc component from the trigger signal.

TABLE 3-1. (Continued)

FIG NO./ INDEX NO.	CONTROL OR CONNECTOR	DESCRIPTION	FUNCTION
3-1, 19 (Cont)			DC: The DC position accepts all trigger frequencies from dc to 90 MHz.
3-1, 20	Delayed EXT INPUT connector	BNC connector A3J301	Connector is used for applying an external triggering signal to the delayed time base generator.
3-1, 21	Main trigger source switch (EXT ÷ 10 EXT INT LINE)	Four-position lever switch A3S101	This switch selects the triggering source for the main time base generator. Position functions are as follows: EXT ÷ 10: Connects main EXT INPUT connector (25) to main time base triggering circuitry through an X10 attenuator. This trigger source is used if external trigger signal is greater than 10 v peak-to-peak. EXT: Connects main time base triggering circuitry directly to main EXT INPUT connector (25). This position is used to trigger main time base generator from

TABLE 3-1. (Continued)

FIG NO./ INDEX NO.	CONTROL OR CONNECTOR	DESCRIPTION	FUNCTION
3-1, 21 (Cont)			an external trigger source of less than 10 v peak-to-peak. INT: Connects main time base triggering circuitry to an internal trigger signal derived from the vertical input signal. This is the normal operating position for this control. LINE: Connects main time base triggering circuitry to a trigger signal taken from the power line waveform. This position is useful for observing a waveform that is a multiple of the line frequency.
3-1, 22	DEL'D TRIG OUTPUT connector	BNC connector A3J301	This connector provides a positive trigger signal output each time the delayed sweep circuit is armed. This output is used to trigger external equipment.

TABLE 3-1. (Continued)

FIG NO./ INDEX NO.	CONTROL OR CONNECTOR	DESCRIPTION	FUNCTION
3-1, 23	Main SLOPE switch	Two-position lever switch A3S103	This switch determines on which slope of the triggering signal the main time base starts. Position functions are as follows: - : In this position the main sweep starts on the negative-going (downward) portion of the triggering signal at a trigger level determined by the setting of the main TRIGGER LEVEL control (26). + : In this position the main sweep starts on the positive-going (upward) portion of the triggering signal at a trigger level determined by the setting of the main TRIGGER LEVEL control (26).
3-1, 24	Main trigger coupling switch (ACS ACF AC DC)	Four-position lever switch A3S102	This switch determines the type of trigger coupling for the main time base. Position functions are as follows:

TABLE 3-1. (Continued)

FIG NO./ INDEX NO.	CONTROL OR CONNECTOR	DESCRIPTION	FUNCTION
3-1, 24 (Cont)			ACS: The ac slow position attenuates signals above approximately 30 kHz. This position is used to remove an undesirable high frequency component from the trigger signal. ACF: The ac fast position attenuates signals below 15 kHz. This position is used to remove the low frequency component (such as 60 Hz ripple) from the trigger signal. AC: The AC position blocks the dc level of the trigger signal. This position is used on frequencies above 20 Hz when it is desirable to remove the dc component from the trigger signal. DC: The DC position accepts all trigger frequencies from dc to 90 MHz. This is the normal coupling position.

TABLE 3-1. (Continued)

FIG NO./ INDEX NO.	CONTROL OR CONNECTOR	DESCRIPTION	FUNCTION
3-1, 25	Main EXT INPUT connector	BNC connector A3J101	Connector is used for applying an external triggering signal to the main time base generator.
3-1, 26	Main TRIGGER LEVEL control	Variable resistor A3R121	Determines voltage level on waveform at which main sweep is triggered. Variable from -5 volts to +5 volts.
3-1, 27	Channel B POSITION control	Variable resistor A2R438	Determines the vertical position of the channel B trace.
3-1, 28	Channel B POLARITY switch	Two-position slide switch A3S401	Selects polarity of channel B vertical display. Position functions are as follows: +UP: Displays positive portion of the channel B input waveform up, or in the normal position. -UP: Displays negative portion of the channel B input waveform up, or in the inverted position.

TABLE 3-1. (Continued)

FIG NO./ INDEX NO.	CONTROL OR CONNECTOR	DESCRIPTION	FUNCTION
3-1, 29	Channel B INPUT connector	BNC Connector A2J201	Input connector for channel B vertical amplifier.
3-1, 30	Channel B input coupling switch (AC GND DC)	Three-position lever switch A2S201	This switch selects the type of coupling for the channel B vertical amplifier. Position functions are as follows: AC: Capacitively couples the channel B input signal to the channel B vertical amplifier. This position is used to block the dc component of a waveform on signals from 2 Hz to 50 MHz. GND: Removes the input signal and grounds the channel B vertical amplifier. This position is used for adjusting dc balance and for accurately positioning the channel B trace prior to measuring dc waveforms.

TABLE 3-1. (Continued)

FIG NO./ INDEX NO.	CONTROL OR CONNECTOR	DESCRIPTION	FUNCTION
3-1, 30 (Cont)			DC: Directly couples the channel B input signal to the channel B vertical amplifier. This position is used for viewing dc waveforms or long duration pulses.
3-1, 31	Channel B vernier VOLTS/ CM control	Variable resistor A2R409	Provides for continuous adjustment of channel B amplitude between calibrated positions of channel B VOLTS/CM switch (32). Position functions are as follows: CAL: Allows vertical amplitude to be determined from channel B VOLTS/CM switch (32) setting. Rotated ccw from CAL: Provides continuous amplitude adjustment between calibrated steps of channel B VOLTS/CM switch (32).

TABLE 3-1. (Continued)

FIG NO./ INDEX NO.	CONTROL OR CONNECTOR	DESCRIPTION	FUNCTION
3-1, 32	Channel B VOLTS/CM switch	12-position rotary switch A2S202	Provides 12 positions of calibrated input attenuation for the channel B amplifier. Input voltage is determined by multiplying the number of centimeters of deflection by the setting of this switch.
3-1, 33	Channel B CAL adjust	Variable resistor A2A3R408	Adjusts channel B vertical amplitude to agree with setting of channel B VOLTS/CM switch (32).
3-1, 34	Channel A INPUT connector	BNC Connector A2J101	Input connector for channel A vertical amplifier.
3-1, 35	Vertical MAGNIFIER (X1 X5)	Two-position slide switch A2S1101	Provides for expanding the vertical trace. Position functions are as follows: X1: Provides a normal trace. X5: Expands vertical trace to five times its normal level. This extends the most sensitive range to 1 mv/cm.

TABLE 3-1. (Continued)

FIG NO./ INDEX NO.	CONTROL OR CONNECTOR	DESCRIPTION	FUNCTION
3-1, 36	Channel A input coupling switch (AC GND DC)	Three-position lever switch A2S101	This switch selects the type of coupling for the channel A vertical amplifier. Position functions are as follows: AC: Capacitively couples the channel A input signal to the channel A vertical amplifier. This position is used to block the dc component of a waveform on signals from 2 Hz to 50 MHz. GND: Removes the input signal and grounds the channel A vertical amplifier. This position is used for adjusting dc balance and for accurately positioning the channel A trace prior to measuring dc waveforms. DC: Directly couples the channel A input signal to the channel A vertical amplifier. This position is used for viewing dc waveforms or long duration pulses.

TABLE 3-1. (Continued)

FIG NO./ INDEX NO.	CONTROL OR CONNECTOR	DESCRIPTION	FUNCTION
3-1, 37	Channel A vernier VOLTS/ CM control	Variable resistor A2R309	Provides continuous adjustment of channel A amplitude between calibrated positions of channel A VOLTS/ CM switch (38). Position functions are as follows: CAL: Allows vertical amplitude to be determined from channel A VOLTS/CM switch (38) setting. Rotated ccw from CAL: Provides continuous amplitude adjustment between calibrated steps of channel A VOLTS/CM switch (38).
3-1, 38	Channel A VOLTS/CM switch	12-position rotary switch A2S102	Provides 12 positions of calibrated input attenuation for the channel A amplifier. Input voltage is determined by multiplying the number of centimeters of deflection by the setting of this switch.

TABLE 3-1. (Continued)

FIG NO./ INDEX NO.	CONTROL OR CONNECTOR	DESCRIPTION	FUNCTION
3-1, 39	Vertical DISPLAY switch	Six-position rotary switch A2S302	Selects type of vertical display to be used. Position functions are as follows: ALT B TRIGGER: Produces two traces displayed on alternate sweeps and allows the operator to observe the channel A and B inputs simultaneously. A trigger signal derived from the channel B input signal is sent to the time base generator to trigger each sweep from the same signal. This position is used with faster sweep speeds for accurate time comparison of the two input signals. CHOP B TRIGGER: Produces two displays on the same sweep by switching each channel on and off at a 400 kHz rate. A trigger signal derived from the channel B input signal is sent to the time base generator to trigger the

TABLE 3-1. (Continued)

FIG NO./ INDEX NO.	CONTROL OR CONNECTOR	DESCRIPTION	FUNCTION
3-1, 42	Channel A POLARITY	Two-position slide switch A2S301	Selects polarity of channel A vertical display. Position functions are as follows: +UP: Displays positive portion of the channel A input waveform up, or in the normal position. -UP: Displays negative portion of the channel A input waveform up, or in the inverted position.
3-1, 43	DC BAL A+B adjust	Variable resistor A2R354	Adjusts dc balance between channels A and B so that no vertical shift occurs when DISPLAY (39) is switched from A or B to A+B.
3-1, 44	DC BAL A adjust	Variable resistor A2R124	Adjusts dc balance between push-pull stages of channel A input amplifier so that no vertical shift occurs when input polarity is switched.
3-1, 45	Channel A POSITION control	Variable resistor A2R338	Determines the vertical position of the channel A trace.

TABLE 3-1. (Continued)

FIG NO./ INDEX NO.	CONTROL OR CONNECTOR	DESCRIPTION	FUNCTION
3-1, 46	CALIBRATOR 10V jack	Banana jack A1J103	Provides a 1 kHz 10v peak-to-peak output that may be used for divider probe compensation.
3-1, 47	CALIBRATOR 250MV jack	Banana jack A1J102	Provides a 1 kHz 250 mv peak-to-peak output that may be used for calibrating vertical amplifier.
3-1, 48	CALIBRATOR GND jack	Banana jack A1J104	Provides a ground connection point.
3-1, 49	POWER switch	DPST toggle A1S401	Applies ac power to oscilloscope. When opened, breaks both hot and neutral input power lines.
3-1, 50	POWER on indicator	Indicating light A1DS401	Lights when POWER switch is closed and the +23 vdc power supply is operating.
3-1, 51	SCALE illumination control	Variable resistor A1R350	Controls scale illumination.
3-1, 52	TRACE ALIGN control	Variable resistor A1R334	Rotates trace around horizontal axis, and is used to align the horizontal trace exactly with the horizontal graticule.

TABLE 3-1. (Continued)

FIG NO./ INDEX NO.	CONTROL OR CONNECTOR	DESCRIPTION	FUNCTION
3-1, 53	FOCUS control	Variable resistor A1R344	Adjusts beam for sharpest trace.
3-1, 54	ASTIGMATISM control	Variable resistor A1R347	Used in conjunction with FOCUS control (53) to adjust for roundness of writing beam.
3-1, 55	FIND BEAM pushbutton	DPDT pushbutton -switch A1S102	If intensity or positioning controls are improperly set or if beam is driven off the screen by a high dc level input signal, pressing the FIND BEAM pushbutton returns the trace to the screen. The positioning controls can then be adjusted to center the beam so that the trace will remain on the screen when FIND BEAM is released.
3-1, 56	INTENSITY control	Variable resistor A1R106	Adjusts brightness of CRT beam.
3-1, 57	PHASE BANDWIDTH switch	Slide switch A1S202	Selects between normal operation and XY operation. Position functions are as follows:

TABLE 3-1. (Continued)

FIG NO./ INDEX NO.	CONTROL OR CONNECTOR	DESCRIPTION	FUNCTION
3-1, 57 (Cont)			BANDWIDTH: Allows the horizontal amplifier to function normally. Switch must be in this position at all times except when making XY phase comparisons. PHASE: Delays the horizontal signal the same amount of time as the vertical input signal. Set the switch to PHASE only when making XY comparisons.

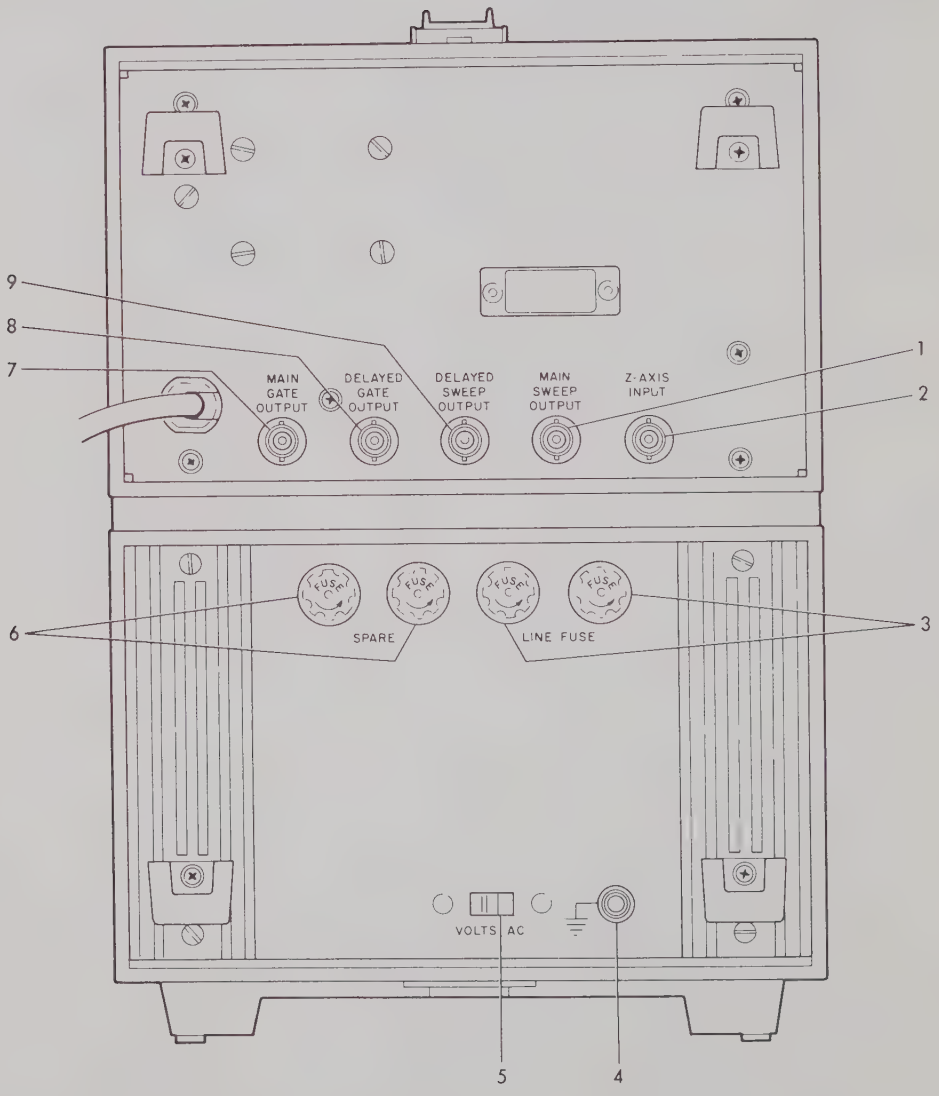

Figure 3-2. Rear-Panel Controls and Connectors

TABLE 3-2. REAR-PANEL OPERATING CONTROLS AND CONNECTORS

FIG NO./ INDEX NO.	CONTROL OR CONNECTOR	DESCRIPTION	FUNCTION
3-2, 1	MAIN SWEEP OUTPUT connector	BNC Connector A1J105	Provides a main sweep output for driving external equipment.
3-2, 2	Z-AXIS INPUT connector	BNC Connector A1J101	Connector for accepting CRT beam intensity modulation signal.
3-2, 3	LINE FUSE	Fuse holders with fuses A1F401 and A1F402	Two 1.25 amp slow-blow fuses provide overload protection when operating on 115 vac. When operating on 230 vac these two fuses must be replaced with two 0.6 amp slow-blow fuses to maintain overload protection.
3-2, 4	Ground connector	Binding post A1J402	Provides a chasis ground connection point.
3-2, 5	VOLTS AC line voltage select switch	Two-position slide switch A1S402	Provides for selection of external power source. Position functions are as follows: 115: Selects the transformer coupling for operating on a 115 vac power source.

TABLE 3-2. (Continued)

FIG NO./ INDEX NO.	CONTROL OR CONNECTOR	DESCRIPTION	FUNCTION
3-2, 5 (Cont)			230: Selects the transformer coupling for operating on a 230 vac power source.
3-2, 6	SPARE	Fuse holders	Contain two spare fuses.
3-2, 7	MAIN GATE OUTPUT connector	BNC Connector A1J108	Provides a main gate output for triggering external equipment.
3-2, 8	DELAYED GATE OUTPUT connector	BNC Connector A1J107	Provides a delayed gate output for triggering external equipment.
3-2, 9	DELAYED SWEEP OUTPUT connector	BNC Connector A1J106	Provides a delayed sweep output for driving external equipment.

3-4. OPERATING PROCEDURES.

Operating procedures for the AN/USM-281 Oscilloscope consist of turn-on and adjustment, vertical amplifier operating procedures and time base and delay generator operating procedures. These procedures are described in the following paragraphs.

3-5. TURN-ON AND ADJUSTMENT PROCEDURE.

Perform the complete turn-on and adjustment procedure when the AN/USM-281 Oscilloscope is turned on for the first time. After the oscilloscope

has been in use, it is not necessary to repeat the initial control settings and the adjustment portions of the procedure each time the unit is turned on. However, the adjustment procedures should be performed periodically to insure the accuracy of the instrument. Table 3-3 lists the turn-on and adjustment procedure for the oscilloscope.

TABLE 3-3. TURN-ON AND ADJUSTMENT PROCEDURE

STEP	PROCEDURE
	Note Perform steps 1 thru 3 before energizing the oscilloscope for the first time. Once the oscilloscope has been in use it should not be necessary to repeat steps 1 thru 3 unless the front-panel controls have been completely misadjusted.
	INITIAL CONTROL SETTINGS
1	Position oscilloscope assembly controls as follows: a. Set INTENSITY, FOCUS, and HORIZONTAL POSITION to center of rotation. b. Set horizontal MAGNIFIER to X1. c. Rotate horizontal DISPLAY fully counterclockwise to INT.
	Note Insure that horizontal DISPLAY control engages switch when set to INT. If switch is not engaged, the internal time base signal is disconnected from the horizontal amplifier.
	d. Set POWER off. e. Set PHASE BANDWIDTH to BANDWIDTH.

TABLE 3-3. (Continued)

STEP	PROCEDURE
	Note To gain access to PHASE BANDWIDTH switch, release the 3 snap fasteners on bottom-right panel and the 3, 1/4-turn fasteners on right-side panel, and raise panel. See figure 3-1 for location of switch.
2	Position time base and delay generator controls as follows: a. Set MAIN VERNIER and DELAYED VERNIER to CAL. b. Set sweep display to MAIN. c. Set delayed TIME/CM to OFF. d. Set SWEEP MODE to AUTO e. Set main trigger source to INT.
3	Position dual channel vertical amplifier controls as follows: a. Set A POSITION and B POSITION to center of rotation. b. Set vertical DISPLAY to A. c. Set channel A and B input coupling to GND. d. Set vertical MAGNIFIER to X1.
	TURN-ON CAUTION Prior to connecting oscilloscope to power source, insure that the VOLTS AC switch on the rear of the instrument is set to the proper voltage and that the four rear-panel fuses are the proper value (1.25 amp slow-blow for 115 vac operation, 0.6 amp slow-blow for 230 v operation).

TABLE 3-3. (Continued)

STEP	PROCEDURE
4	Connect oscilloscope power cord to power source.
	WARNING If power cord adapter is used, insure that adapter lead is grounded.
5	Set POWER switch on. POWER on indicator lights. Trace should appear in approximately 15 seconds.
	Note If trace does not appear after waiting sufficient time for warm-up, press FIND BEAM pushbutton and adjust positioning controls to center trace with FIND BEAM depressed. If trace disappears when FIND BEAM is released, increase INTENSITY until trace reappears.
6	When trace appears, adjust INTENSITY for desired brightness, and HORIZONTAL POSITION and A POSITION controls to center trace.
7	Rotate horizontal DISPLAY clockwise to EXT CAL. Spot appears on CRT.
8	Center spot with HORIZONTAL POSITION and A POSITION controls
9	Adjust FOCUS for sharpest spot. If spot is not round, adjust ASTIGMATISM and FOCUS as required to produce clear round spot.
10	Rotate horizontal DISPLAY counterclockwise to INT. Trace reappears.

TABLE 3-3. (Continued)

STEP	PROCEDURE
	Note Wait a minimum of 15 minutes before performing the remaining adjustments. These adjustments should be performed when the instrument is energized for the first time after receipt and should be performed periodically to insure accurate voltage measurements. It should not be necessary to repeat these procedures each time the instrument is used.
	INTENSITY RATIO ADJUSTMENT
11	Set CM DELAY to 2.
12	Set main TIME/CM to 50 USEC.
13	Rotate delayed TIME/CM counterclockwise to 5 USEC. An intensified trace appears approximately 2 centimeters from left side of screen.
14	If required, adjust INTENS RATIO for desired intensity contrast between main and delayed sweeps.
15	Rotate delayed TIME/CM clockwise to OFF.
	VERTICAL AMPLIFIER CHANNEL A AND CHANNEL B DC BALANCE
	Note Insure that channel A and B input coupling switches are set to GND before performing dc balance adjustment.
16	Set channel A and channel B POLARITY to +UP.
17	Using A POSITION control, position the trace exactly on the center horizontal graticule.
18	Set channel A POLARITY to -UP and observe trace.

TABLE 3-3. (Continued)

STEP	PROCEDURE
19	If trace shifted position vertically when POLARITY was switched, adjust DC BAL A adjust screw to return trace approximately 1/2 the distance from its present position to the center graticule.
20	Set channel A POLARITY to +UP and repeat steps 17 thru 20 as required until no visible shift in trace occurs when switching channel A POLARITY between the +UP and -UP positions.
21	Set vertical DISPLAY to B.
22	Using B POSITION control, position the trace exactly on the center horizontal graticule.
23	Set channel B POLARITY to -UP and observe trace.
24	If trace shifted position vertically when polarity was switched, adjust DC BAL B adjust screw to return trace approximately 1/2 the distance from its present position to the center graticule.
25	Set channel B POLARITY to +UP and repeat steps 22 thru 25 as required until no visible shift in trace occurs when switching channel B POLARITY between the +UP and -UP positions.
	VERTICAL AMPLIFIER SENSITIVITY ADJUSTMENT.
26	Set channel B input coupling to AC.
27	Rotate channel B vernier VOLTS/CM control fully clockwise to CAL.
28	Set channel B VOLTS/CM to .005.
29	Set vertical MAGNIFIER to X1.
30	Connect 10:1 divider probe to channel B INPUT connector.
31	Connect divider probe to CALIBRATOR 250MV output jack.

TABLE 3-3. (Continued)

STEP	PROCEDURE
32	Adjust channel B CAL screw for exactly 5 cm of vertical deflection. Reposition trace with B POSITION control as desired to complete adjustment.
33	Disconnect divider probe from oscilloscope.
34	Set channel B input coupling to GND.
35	Set channel A input coupling to AC.
36	Rotate channel A vernier VOLTS/CM control fully clockwise to CAL.
37	Set channel A VOLTS/CM to .005.
38	Set vertical DISPLAY to A.
39	Connect 10:1 divider probe to channel A INPUT connector.
40	Connect divider probe to CALIBRATOR 250MV output jack.
41	Adjust channel A CAL screw for exactly 5 cm of vertical deflection. Reposition trace with A POSITION control as desired to complete adjustment.
42	Disconnect divider probe from oscilloscope.
	VERTICAL AMPLIFIER COMBINED CHANNEL (A+B) DC BALANCE
43	Set channel A input coupling to GND.
44	Using A POSITION control, position trace exactly on center horizontal graticule.
45	Set vertical DISPLAY to B.

TABLE 3-3. (Continued)

STEP	PROCEDURE
46	Using B POSITION control, position trace exactly on center graticule.
47	Set vertical DISPLAY to A+B and observe trace.
48	If trace shifts vertically, adjust DC BAL A+B screw to reposition trace on center graticule.

3-6. DUAL CHANNEL VERTICAL AMPLIFIER OPERATING PROCEDURES.

The dual channel vertical amplifier has three modes of operation: single or dual channel operation, A+B operation and XY operation. A brief description of the purpose and use of each mode of operation is given in the following paragraphs.

a. SINGLE OR DUAL CHANNEL OPERATION. - This mode of operation allows the operator to observe and accurately measure the voltage level of a single waveform displayed on one trace, or to observe and measure two separate waveforms displayed on two separate traces. The dual trace feature also allows accurate time comparison of two separate waveforms. When using the oscilloscope to measure voltage, the vernier VOLTS/CM controls must be set to CAL. The voltage is then determined by multiplying the number of centimeters of deflection by the setting of the appropriate VOLTS/CM control. To use the oscilloscope for time comparison of two separate waveforms, the DISPLAY switch must be set to the ALT B TRIGGER or CHOP B TRIGGER position. The ALT B TRIGGER position is used for faster sweeps, and the CHOP B TRIGGER position is used for slower sweep speeds. Experience with the oscilloscope will allow the operator to select the proper position for the particular waveforms to be compared. Table 3-4 gives the procedure for setting the controls for single or dual channel operation.

TABLE 3-4. SINGLE OR DUAL CHANNEL OPERATING PROCEDURE

STEP	PROCEDURE
1	Perform turn-on procedure. (See table 3-3.)
2	Set vertical DISPLAY switch to desired position. (For single trace either channel A or channel B may be used. For dual trace select the display mode in accordance with the comparison to be made and the sweep speed to be used.)
3	Set sweep speed as desired. (Refer to paragraph 3-7 for time base operation.)
	Note If vertical DISPLAY switch is set for dual trace, perform following steps on both channel controls. If single channel is used, perform following steps on the channel corresponding to setting of vertical DISPLAY switch.
4	Set vernier VOLTS/CM control to CAL. (If accurate voltage measurement is not required, this control can be used to vary vertical deflection.)
5	Set VOLTS/CM as desired.
6	Set vertical MAGNIFIER to X1. (Vertical MAGNIFIER can be set to X5 to expand the vertical trace or to increase vertical amplifier gain on low amplitude signals.)
7	Set input coupling to AC or DC as desired.
8	Connect signal(s) to INPUT connector(s).
9	Set POLARITY to +UP or -UP as desired.
10	Adjust A POSITION and/or B POSITION as desired.

b. A+B OPERATION.- The A+B mode of operation is used to algebraically combine two waveforms on a single trace. In this mode, the POLARITY setting of each channel determines whether the display is the sum or difference of the input signals. The combination of displays provided are A+B, -A(+)-B, A-B, and B-A. Table 3-5 provides the control settings for A+B operation.

TABLE 3-5. A+B OPERATING PROCEDURE

STEP	PROCEDURE
1	Perform turn-on procedure. (See table 3-3.)
2	Set channel A and B input coupling to GND.
3	Set vertical DISPLAY to A.
4	Set sweep speed as desired. (Refer to paragraph 3-7 for time base operation.)
5	Center trace vertically with A POSITION control.
6	Set vertical DISPLAY to B.
7	Center trace vertically with B POSITION control.
8	Set vertical DISPLAY switch to A+B.
9	Set input coupling switches to AC or DC as desired.
10	Set vertical MAGNIFIER to X1. (Vertical MAGNIFIER can be set to X5 to increase amplitude of the combined signals.)
11	Connect signals to channel A and B INPUT connectors.
12	Set channel A and B vernier VOLTS/CM controls to CAL.
13	Set channel A and B VOLTS/CM switches as desired.
14	Set the channel A and B POLARITY switches to provide the combination desired.

c. XY OPERATION.- The XY mode of operation provides a method of determining the phase relationship of two waveforms. In this mode of operation, one waveform is applied to the vertical amplifier and the second waveform is applied to the horizontal amplifier. The Lissajous pattern produced allows the operator to determine phase relationship of the two waveforms. When the XY mode of operation is used to compare phase, the PHASE BANDWIDTH switch must be set to PHASE (to delay the horizontal signal the same amount of time as the vertical signal) to provide an accurate comparison. In addition to phase comparison, the XY mode also allows the operator to use an externally generated time base signal rather than the internal time base signal. Table 3-6 provides the control settings for XY operation.

TABLE 3-6. XY OPERATING PROCEDURE

STEP	PROCEDURE
1	Perform turn-on procedure. (See table 3-3.)
2	Set vertical DISPLAY to A, B, or A+B as desired.
3	Set channel A and B input coupling to GND.
4	Set channel A and B VOLTS/CM and POLARITY switches as desired.
	Note If measuring phase relationship, perform step 5; otherwise proceed with step 6.
5	Set PHASE BANDWIDTH switch to PHASE.
	Note To gain access to PHASE BANDWIDTH switch, release the 3 snap fasteners on the right-bottom panel and the 3, 1/4 turn fasteners on right-side panel, and raise panel. See figure 3-1 for location of switch.

TABLE 3-6. (Continued)

STEP	PROCEDURE
6	Connect horizontal signal to horizontal amplifier EXT INPUT connector.
7	Set horizontal amplifier external input coupling switch to AC or DC as desired.
8	Adjust horizontal DISPLAY and horizontal MAGNIFIER for desired amount of deflection.
9	Connect vertical signal to A and/or B INPUT connector.
10	Set appropriate vertical amplifier input coupling switch(es) to AC or DC as desired.
11	Set vertical MAGNIFIER to X1 or X5 as desired.
	Note Insure that PHASE BANDWIDTH switch is returned to BANDWIDTH after completing phase comparison.

3-7. TIME BASE AND DELAY GENERATOR OPERATION.

The time base and delay generator has four modes of operation: main sweep operation, mixed sweep operation, delayed sweep operation and single sweep operation. A brief description of the purpose and use of each mode of operation is given in the following paragraphs.

a. MAIN SWEEP OPERATION.- The main sweep mode of operation produces a normal trace for observing simple waveforms applied to the vertical amplifier. This mode is used when the displayed waveform is simple and fairly uniform (horizontally) through the period of the waveform, or when the operator is only concerned with the vertical amplitude of the waveform. If a more complex, non-uniform waveform is to be displayed, the mixed or delayed mode is used to observe the waveform in more detail. Table 3-7 provides the procedure for main sweep operation.

TABLE 3-7. MAIN SWEEP OPERATING PROCEDURE

STEP	PROCEDURE
1	Perform turn-on procedure. (See table 3-3.)
2	Set horizontal DISPLAY to INT.
3	Set sweep display to MAIN.
4	Set SWEEP MODE to AUTO.
5	Rotate delayed TIME/CM fully clockwise to OFF.
6	Center trace with HORIZONTAL POSITION controls.
7	Set horizontal MAGNIFIER to X1. (MAGNIFIER can also be used to expand the trace to X5 or X10.)
8	Connect signal to vertical amplifier. (Refer to paragraph 3-6.)
9	Set main trigger source to desired position. (INT is the normal position. If either of the EXT positions are selected, connect a trigger signal to main EXT INPUT connector.)
10	Set main trigger coupling to desired position. (DC is the normal coupling position. Select ACF to reject frequencies below 15 kHz, ACS to reject frequencies above 30 kHz, and AC to reject the dc component and frequencies below 20 Hz.)
11	Set main SLOPE to + or - as desired.
12	Adjust main TRIGGER LEVEL for desired trigger point. If display is unstable, set SWEEP MODE to NORM and adjust TRIGGER LEVEL.
13	Rotate MAIN VERNIER fully clockwise to CAL. (If accurate time measurement is not required, this control can be used for fine adjustment of main sweep speed.)
14	Set main TIME/CM as desired.

b. MIXED SWEEP OPERATION.- The mixed sweep mode of operation provides a trace (time base) that is a combination of the main sweep and the delayed sweep. In this mode the first portion of the displayed trace is produced by the main time base generator and the second portion of the trace is produced by the delayed time base generator. The time or position on the main sweep at which the delayed sweep starts is determined by the setting of the CM DELAY control. This mode of operation is very useful in analyzing complex waveforms. By properly setting the CM DELAY control and the delayed TIME/CM switch, the operator can expand and observe any compressed area of a complex waveform. Table 3-8 provides the procedure for mixed sweep operation.

TABLE 3-8. MIXED SWEEP OPERATING PROCEDURE

STEP	PROCEDURE
1	Perform main sweep operating procedure. (See table 3-7.)
2	Rotate DELAYED VERNIER fully clockwise to CAL. (If accurate delayed sweep speed is not required, this control can be used for fine adjustment of delayed sweep speeds.)
3	Set delayed trigger source to AUTO. (If trigger source other than AUTO is selected, delayed sweep starts on the first trigger signal received after delay time. Set delayed TRIGGER LEVEL, trigger SLOPE, and trigger coupling controls as desired.)
4	Rotate delayed TIME/CM counterclockwise from OFF to a speed approximately 10 to 100 times faster than main sweep speed. (If main sweep speed is set faster than 1 usec/cm it is not possible to set delayed sweep 10 times faster than main sweep.)
5	Rotate CM DELAY clockwise from 0 until a portion of the sweep is intensified, then adjust CM DELAY to position the intensified trace over the portion of the waveform to be expanded.
	Note The length of the intensified trace can be increased or decreased by resetting the delayed TIME/CM.

TABLE 3-8. (Continued)

STEP	PROCEDURE
6	Set sweep display to MIXED.
7	Adjust CM DELAY and delayed TIME/CM as desired to expand any portion of the waveform.

c. DELAYED SWEEP OPERATION.- The delayed sweep mode of operation produces the delayed sweep only, at a delay time determined by the Product of the CM DELAY control and the main TIME/CM switch. The difference between this mode and the mixed sweep mode is that the main sweep does not appear in the display and the delayed sweep covers the full 10 cm deflection. This allows the delayed sweep to expand or magnify a portion of the waveform the full width of the screen. Table 3-9 provides the procedure for delayed sweep operation. In addition to providing a method of expanding a complex waveform for observation, the delayed mode is also used to make rise time measurements and time differential measurements. Procedures for making accurate rise time measurements are provided in table 3-10. Procedures for making time differential measurements are provided in table 3-11.

TABLE 3-9. DELAYED SWEEP OPERATING PROCEDURE

STEP	PROCEDURE
1	Perform main sweep operating procedure. (See table 3-7.)
2	Rotate DELAYED VERNIER fully clockwise to CAL. (If accurate delayed sweep speed is not required, this control can be used for fine adjustment of delayed sweep speed.)
3	Set delayed trigger source to AUTO.

TABLE 3-9. (Continued)

STEP	PROCEDURE
4	Rotate delayed TIME/CM counterclockwise from OFF to a speed approximately 10 to 100 times faster than main sweep. (If main sweep speed is set faster than 1 usec/cm it is not possible to set delayed sweep 10 times faster than main sweep.)
5	Rotate CM DELAY clockwise from 0 until intensified portion of the trace appears over portion of waveform to be expanded. Note The length of the intensified trace can be increased or decreased by resetting the delayed TIME/CM.
6	Set sweep display to DELAYED.
7	Adjust CM DELAY and delayed TIME/CM as desired to observe any portion of the waveform.

TABLE 3-10. RISE TIME MEASUREMENT PROCEDURE

STEP	PROCEDURE
1	Perform main sweep operating procedure. (See table 3-7.)
2	Rotate delayed TIME/CM counterclockwise from OFF.
3	Set DELAYED VERNIER to CAL.
4	Set delayed trigger source switch to INT, EXT, or EXT ÷ 10 as desired. (INT is the normal setting. If either of the EXT positions are selected, connect a trigger signal to delayed EXT INPUT connector.)

TABLE 3-10. (Continued)

STEP	PROCEDURE
5	Set delayed trigger coupling to desired position. (DC is the normal coupling position. Select ACF to reject frequencies below 15 kHz, ACS to reject frequencies above 30 kHz, and AC to reject the dc component and frequencies below 20 Hz.)
6	Set delayed SLOPE to + or - as desired.
7	Adjust delayed TRIGGER LEVEL for an intensified display. (If intensified display does not appear, set CM DELAY to 1.00 and readjust TRIGGER LEVEL as required.)
8	Adjust CM DELAY to position intensified trace over portion of waveform to be measured.
9	Set sweep display to DELAYED.
10	Set delayed TIME/CM and CM DELAY as desired to display portion of waveform to be measured.
11	Adjust vertical controls to obtain a centered trace exactly 8 cm in amplitude.
12	Using the CRT graticule, measure and record the distance in cm between the 10% and 90% amplitude points.
	Note If vertical amplitude is exactly 8 cm the dotted horizontal lines on the CRT graticule are the 10% and 90% amplitude points.
13	Multiply the distance in cm (obtained in step 12) by the setting of the delayed TIME/CM switch to obtain rise time.

TABLE 3-11. TIME DIFFERENTIAL MEASUREMENT PROCEDURE

STEP	PROCEDURE
1	Perform main sweep operating procedure. (See table 3-7.)
2	Rotate DELAYED VERNIER and MAIN VERNIER fully clockwise to CAL.
3	Rotate delayed TIME/CM counterclockwise from OFF to a speed approximately 10 to 100 faster than main sweep. (If main sweep speed is set faster than 1 usec/cm it is not possible to set delayed sweep 10 times faster than main sweep.)
4	Set delayed trigger source to AUTO.
5	Adjust CM DELAY to position intensified trace over first point of interest on waveform. (Reset delayed TIME/CM if required.)
6	Set sweep display to DELAYED.
7	Readjust CM DELAY to position point of interest on waveform exactly on a vertical reference line (normally the center vertical line of the graticule).
8	Record setting of CM DELAY control.
9	Set sweep display to MAIN.
10	Adjust CM DELAY to position intensified trace over second point of interest on waveform.
11	Set sweep display to DELAYED.
12	Readjust CM DELAY to position second point of interest on waveform exactly on the vertical reference line (same reference line used in step 7).
13	Record setting of CM DELAY control.

TABLE 3-11. (Continued)

STEP	PROCEDURE
14	Calculate the difference between the setting of the CM DELAY control recorded in step 8 and the setting recorded in step 13.
15	Multiply the main TIME/CM setting by the difference obtained in step 14 to obtain the time differential between the two points of interest on the waveform.

d. SINGLE SWEEP OPERATION.- The primary purpose of the single sweep mode of operation is to provide a single trace for use when making a photographic recording. This single sweep can be used with any of the previous sweep modes (main sweep, mixed sweep or delayed sweep). The procedure for obtaining a single sweep is given in table 3-12.

TABLE 3-12. SINGLE SWEEP OPERATING PROCEDURE

STEP	PROCEDURE
1	Perform any previous time base operating procedure. (Tables 3-7 thru 3-11.)
2	Set SWEEP MODE to SINGLE.
3	Press RESET pushbutton-indicator to arm sweep. The RESET pushbutton-indicator lights, indicating sweep is armed. The first trigger input will start the sweep and the RESET indicator will go off at the end of the sweep. To repeat the cycle, press RESET pushbutton-indicator.

3-8. OPERATOR'S MAINTENANCE.

Operator's maintenance of the AN/USM-281 Oscilloscope is limited to fuse replacement and periodic cleaning of the exterior surfaces of the instrument. Detailed checkout and trouble shooting require external test equipment and usually require internal adjustment if a component is replaced. Therefore, these procedures are covered in Sections 4 and 5 and should be performed only by a qualified technician. The following paragraphs further identify and explain operator's maintenance.

a. OPERATING CHECKS AND ADJUSTMENTS.- Checkout and adjustment of the oscilloscope requires the use of accurate external test equipment and is not normally performed by the operator. Section 5 gives a detailed reference standards procedure for the oscilloscope and the periodic internal adjustments required to maintain the accuracy of the oscilloscope. Operator's adjustment is limited to the front-panel adjustments provided in table 3-3. These adjustments should be performed periodically to insure the accuracy of the instrument and should be checked before making a voltage measurement when a high degree of accuracy is required.

b. PREVENTIVE MAINTENANCE.- Preventive maintenance for the oscilloscope consists of periodically cleaning the exterior surfaces of the oscilloscope with a soft cloth or dry compressed air (not to exceed 10 psig) and checking controls for security of attachments. The oscilloscope is convection cooled and therefore requires that the external surfaces be kept free from dirt and grease to allow proper heat dissipation.

c. EMERGENCY MAINTENANCE.- Emergency maintenance is limited to replacing power supply and high voltage supply fuses. Figure 3-3 locates and identifies the fuses used in the oscilloscope, and also locates spare fuses stored in the oscilloscope. The spare fuses are located in clips adjacent to the fuse holder and a new fuse should be installed in the spare fuse clip as soon as possible after use. To gain access to the internal fuses, release the 3 snap-fasteners on the left-bottom panel and the 3, 1/4-turn fasteners on the oscilloscope left-side panel, and raise the panel.

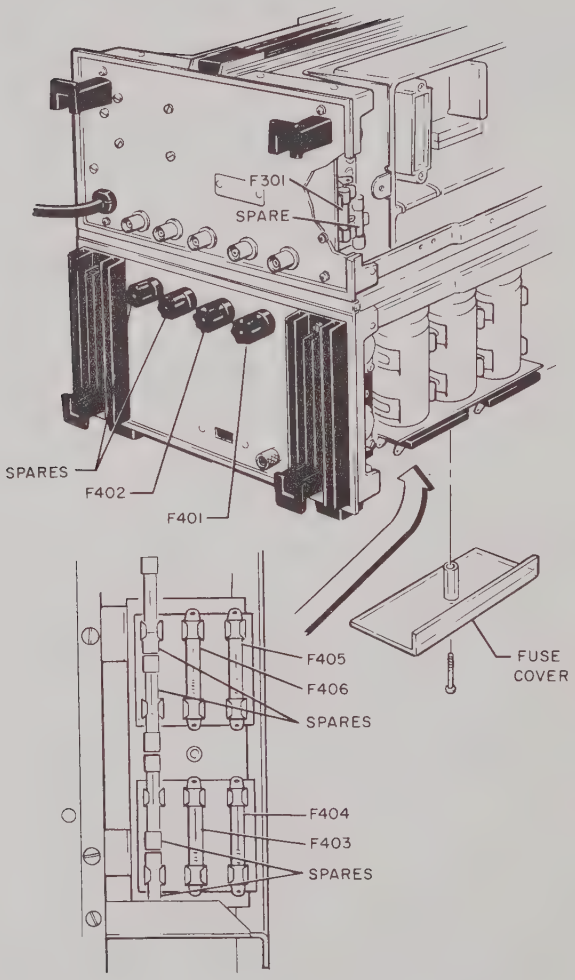

Figure 3-3. Fuse Location Diagram

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